

Reissue Application of Patent No. 5,978,125
Attorney's Docket No.:12361-014002

In the Claims:

Please amend the claims as follows:

1-30. (Previously cancelled)

31. (Previously presented) A variable optical delay device, comprising a plurality of variable optical delay units cascaded to form an optical path through which an optical beam is directed, each variable optical delay unit producing a variable optical delay and comprising:

a polarization rotator operable to control a polarization of received light in response to a unit control signal;

a birefringent segment formed of a birefringent material and located in said optical path to receive output light from said polarization rotator and to transmit received light along said optical path; and

a unit control element, coupled to said polarization rotator to supply said unit control signal, to control light received by said birefringent segment in a first polarization state to cause a first optical delay in light output by said birefringent segment and in a second polarization state to cause a second, different optical delay in light output by said birefringent segment.

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32. (Previously presented) The device as in claim 31,
wherein said birefringent material includes a birefringent
crystal.

33. (Previously presented) The device as in claim 31,
wherein said birefringent material includes a PM fiber.

34. (Previously presented) The device as in claim 31,
wherein different birefringent segments in different variable
optical delay units have different lengths along said optical
path.

35. (Previously presented) The device as in claim 34,
wherein two adjacent different birefringent segments differ in
length by a constant factor.

36. (Previously presented) The device as in claim 35,
wherein said constant factor is 2.

37. (Previously presented) The device as in claim 34,
wherein lengths of said different birefringent segments increase
successively along said optical path from a first variable
optical delay unit that receives an optical beam to a last
variable optical delay unit that outputs said optical beam.

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38. (Previously presented) The device as in claim 34,
wherein said variable optical delay units includes a first
variable optical delay unit whose birefringent segment is formed
of a first birefringent material and a second variable optical
delay unit whose birefringent segment is formed of a second
birefringent material that has birefringence different from said
first birefringent material.

39. (Previously presented) The device as in claim 34,
wherein at least one birefringent segment in one variable
optical delay unit is formed of a birefringent material that is
responsive to an index-control signal to change a refractive
index and thus an associated optical delay therein to fine tune
a total variable optical delay.

40. (Previously presented) The device as in claim 31,
wherein said variable optical delay units includes a first
variable optical delay unit whose birefringent segment is formed
of a first birefringent material and a second variable optical
delay unit whose birefringent segment is formed of a second
birefringent material that has birefringence different from said
first birefringent material.

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41. (Previously presented) The device as in claim 31,
wherein at least one birefringent segment in one variable
optical delay unit is formed of a birefringent material that is
responsive to an index-control signal to change a refractive
index and thus an associated optical delay therein to fine tune
a total variable optical delay.

42. (Previously presented) The device as in claim 41,
wherein said birefringent material exhibits an electro-optic
effect and said index-control signal is an electric field, and
wherein said one variable optical delay unit further includes a
pair of electrodes coupled to said birefringent segment to
supply said electric field.

43. (Previously presented) The device as in claim 41,
wherein different birefringent segments in different variable
optical delay units have different lengths along said optical
path.

44. (Previously presented) The device as in claim 41,
wherein birefringent segments in at least two variable optical
delay units are formed of different birefringent materials.

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45. (Previously presented) The device as in claim 31,
further comprising a ladder-structured optical module optically
coupled in said optical path to receive an output beam from said
plurality of variable optical delay units, wherein said ladder-
structured optical module includes:

a plurality of ladder units stacked over one another
to form a first optical path along which said output beam is
received and a second optical path along which said output beam
is exported to produce an additional variable optical delay; and

a common corner reflector coupled to said plurality of
ladder units to reflect transmitted light from said first
optical path to said second optical path,

wherein each ladder unit comprises:

a first polarization beamsplitter located in said
first optical path to transmit light in a transmitting
polarization and to reflect light in a reflecting polarization
orthogonal to said transmitting polarization;

a second polarization beamsplitter located in said
second optical path and coupled to said first polarization
beamsplitter to receive light reflected from said first
polarization beamsplitter and to direct received light to said
second optical path, said first and said second polarization
beamsplitters forming a polarization-sensitive corner reflector
which transmits light of said transmitting polarization along

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said first optical path towards said common corner reflector and directs light of said reflecting polarization along said second optical path away from said common corner reflector;

a first polarization rotator in said first optical path and adjacent to said first polarization beamsplitter to control a polarization of light entering said first polarization beam splitter to vary an optical delay of said light when exiting said ladder-structured optical module;

a second polarization rotator in said second optical path and adjacent to said second polarization beamsplitter to control a polarization of light exiting said second polarization beam splitter in a manner identical to said first polarization rotator; and

a control unit coupled to control said first and said second polarization rotators.

46. (Previously presented) The device as in claim 45, wherein at least a portion of successive ladder units are spaced from one another by different distances.

47. (Previously presented) The device as in claim 46, wherein a distance between two adjacent ladder units in said portion increase successively by a factor of 2.

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48. (Previously presented) The device as in claim 31,
wherein said polarization rotator in each variable optical delay
unit is selected from a group consisting of a liquid crystal
polarization rotator, a half-wave plate polarization rotator, a
magneto-optic polarization rotator, and an electro-optic
polarization rotator.

49. (Previously presented) A variable optical delay device,
comprising a plurality of variable optical delay units arranged
relative to one another to form an optical path through which an
optical beam is directed, each variable optical delay unit
comprising:

a polarization rotator operable to control a
polarization of received light in response to a unit control
signal;

a PM fiber segment located in said optical path to
receive output light from said polarization rotator and to
transmit received light along said optical path; and

a unit control element, coupled to said polarization
rotator to supply said unit control signal, to control light
received by said PM fiber segment in a first polarization state
to cause a first optical delay in light output by said PM fiber
segment and in a second polarization state to cause a second,

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different optical delay in light output by said PM fiber segment.

50. (Previously presented) The device as in claim 49, wherein each PM fiber segment in one variable optical delay unit has a length along said optical path different from lengths of other PM fiber segments in other variable optical delay units.

51. (Previously presented) The device as in claim 50, wherein said polarization rotator in each variable optical delay unit is selected from a group consisting of a liquid crystal polarization rotator, a half-wave plate polarization rotator, a magneto-optic polarization rotator, and an electro-optic polarization rotator.

52. (Previously presented) The device as in claim 50, wherein lengths of PM fiber segments along said optical path of two adjacent variable optical delay units are different by a constant factor of 2.

53. (Previously presented) The device as in claim 50, wherein at least two PM fiber segments in two different variable optical delay units exhibit different amounts of birefringence.

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54. (Previously presented) The device as in claim 50,
wherein at least one PM fiber segment in one variable optical
delay unit is configured to change a refractive index in
response to a control signal, and wherein said one variable
optical delay unit further includes an index control element
coupled to supply said control signal to vary said refractive
index and thus adjust an optical delay in light output by said
one variable optical delay unit in addition to a control of said
optical delay by said polarization rotator.

55. (Previously presented) The device as in claim 54,
wherein said one PM fiber segment exhibits an electro-optic
effect and said index-control signal is an electric field, and
wherein said one variable optical delay unit further includes a
pair of electrodes.

56. (Previously presented) A method for producing a
variable optical delay in an optical beam, comprising:
causing the optical beam to transmit through a plurality of
birefringent segments along an optical path;
causing polarization states of the optical beam upon
respective entries of the plurality of birefringent segments to
be controlled at a first set of polarization states,

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respectively, to produce a first optical delay in the optical beam upon exiting the plurality of birefringent segments; and causing a polarization state of the optical beam upon entry of at least one of the plurality of birefringent segments to be changed to produce a second, different optical delay in the optical beam upon exiting the plurality of birefringent segments.

57. (Previously presented) The method as in claim 56, further comprising causing the plurality of birefringent segments to have different lengths along the optical path.

58. (Previously presented) The method as in claim 57, wherein lengths of two adjacent birefringent segments are different by a factor of 2.

59. (Previously presented) The method as in claim 56, further comprising causing at least two of the plurality of birefringent segments to be formed of different birefringent materials with different amounts of birefringence.

60. (Previously presented) The method as in claim 56, further comprising:

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causing at least one birefringent segment to include a birefringent material that changes a refractive index in response to an index control signal; and
causing the index control signal to be applied to the birefringent material to modify the second optical delay.

61. (Previously presented) The method as in claim 60, further comprising causing each of the birefringent segments to include a PM fiber segment.

62. (Previously presented) The method as in claim 56, further comprising causing the birefringent segments to include PM fiber segments.

63. (Previously presented) The method as in Claim 62, further comprising causing two different PM fiber segments to have different amounts of birefringence.

64. (Previously presented) A device having a variable optical delay mechanism, comprising:

a plurality of variable optical delay units cascaded to form a plurality of parallel optical paths, each variable optical delay unit comprising (1) a polarization rotator array of a plurality of polarization rotators respectively located in

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said parallel optical paths, and (2) a birefringent segment formed of a birefringent material and located in said parallel optical paths to receive and transmit output light from said polarization rotator array, wherein each polarization rotator is operable to control a polarization of received light in a first polarization state to cause a first optical delay in light output by said birefringent segment and in a second polarization state to cause a second, different optical delay in light output by said birefringent segment; and

a detector array of a plurality of optical detectors respectively located in said parallel optical paths to receive output beams output from said plurality of variable optical delay units to produce a plurality of detector signals corresponding to said output beams of said parallel optical paths.

65. (Previously presented) The device as in claim 64, wherein different birefringent segments have different lengths along said parallel optical paths.

66. (Previously presented) The device as in claim 65, wherein lengths of two adjacent birefringent segments are different by a factor of 2.

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67. (Previously presented) The device as in claim 64,
wherein at least two of said plurality of birefringent segments
are formed of different birefringent materials with different
amounts of birefringence.

68. (Previously presented) The device as in claim 64,
further comprising a laser array of lasers responding to a
plurality of electrical signals to produce a plurality of laser
beams respectively directed into said parallel optical paths,
wherein said detector signals respectively represent said
electrical signals with different delays optically produced by
said plurality of variable optical delay units.

69. (Previously presented) The device as in claim 64,
further comprising:

a laser driven by an electrical signal to produce a
laser beam that carries information in said electrical signal;
and

a lens located between said laser and said plurality
of variable optical delay units to expand said laser beam and to
direct said expanded laser beam to cover said parallel optical
paths formed by said plurality of variable optical delay units,
wherein different parts of said expanded laser beam undergo
different optical delays through said plurality of variable

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optical delay units and said detector signals are replica of
said electrical signal with different delays.

70. (Previously presented) The device as in claim 69,
further comprising a grid amplifier that amplifies said detector
signals.

71. (Previously presented) The device as in claim 69,
further comprising an electrical signal combiner coupled to said
detector array to combine said detector signals to produce a
single detector output that represents a filtered result of said
electrical signal.

72. (Previously presented) A method, comprising:
causing generation of an optical beam to carry
information of an input electrical signal;
causing the optical beam to be expanded to allow for
different parts of the optical beam to transmit through
different optical paths that go through a plurality of
birefringent segments;
causing polarization states of the different parts of
the expanded optical beam upon entry of the plurality of
birefringent segments to be controlled to produce different

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optical delays on the different parts of the expanded optical beam upon exiting the plurality of birefringent segments; and
causing different parts of the expanded optical beam to be converted into a plurality of electrical output signals.

73. (Previously presented) The method as in claim 72,
further comprising causing the electrical output signals to be combined into a single electrical output signal that represents a filtered result of the input electrical signal.

74. (Previously presented) The method as in claim 72,
further comprising causing the plurality of birefringent segments to have different lengths along the parallel optical paths.

75. (Previously presented) The method as in claim 72,
wherein lengths of two adjacent birefringent segments are different by a factor of 2.

76. (Previously presented) The method as in claim 72,
further comprising causing at least two of the plurality of birefringent segments to be formed of different birefringent materials with different amounts of birefringence.

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77. (Previously presented) A method, comprising:

causing generation of a plurality of optical beams to
carry information of a plurality of input electrical signals;

causing the optical beams to transmit through
different optical paths that go through a plurality of
birefringent segments;

causing polarization states of the optical beams upon
entry of the plurality of birefringent segments to be controlled
to produce different optical delays on the different optical
beams upon exiting the plurality of birefringent segments; and

subsequently causing different optical beams to be
converted into a plurality of electrical output signals that
represent the input electrical signals with different delays.

78. (Previously presented) The method as in claim 77,
further comprising causing the plurality of birefringent
segments to have different lengths along the parallel optical
paths.

79. (Previously presented) The method as in claim 78,
wherein lengths of two adjacent birefringent segments are
different by a factor of 2.

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80. (Previously presented) The method as in claim 77,
further comprising causing at least two of the plurality of
birefringent segments to be formed of different birefringent
materials with different amounts of birefringence.